The Feldstein Horioka Puzzle by groups of OECD members: the panel approach.

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Abstract

This paper investigates investment savings relationships in 26 OECD countries and how these relationships change when countries in the considered panel vary. Therefore panel estimations using annual data for the period 1970-2008 are made for different groups of developed countries, such as the OECD, EU15, NAFTA and G7. Additionally, this paper examines changes in investment saving relationships in groups of developed countries taking into account the presence of structural shifts in countries where they exist. Recent panel techniques are employed in this study to examine investment savings relationships and to estimate saving retention coefficients. The empirical findings reveal that the Feldstein-Horioka puzzle exists only in the panel of G7 countries where the saving-retention coefficient is estimated at the level 0.754 and 0.864 for the full sample of G7 countries and for stable countries, respectively. The estimated saving-retention coefficient for the G7 group of unstable appear at the 0.482 level, indicating a higher level of capital mobility in unstable countries compared to stable ones. This conclusion is supported by estimations for OECD and EU15 countries.

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Key Words: Feldstein-Horioka puzzle, capital mobility, structural breaks, panel estimations, OECD.

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1. Introduction

For last three decades numerous studies have been carried out in attempts to explain and to solve the Feldstein Horioka puzzle. The phenomenon of the Feldstein Horioka puzzle (FHP) is related to the seminal work of Feldstein and Horioka (1980). In their study they found that investment and saving ratios are correlated highly in developed countries, which is an illustration of low capital mobility. These findings are opposite to the expected low correlation between investment and savings ratios particularly in the sample of the OECD developed countries. Since then in the literature a great deal of attention has been given to the FHP (see, for example, literature surveys by Frankel [1992], Coakley et al. [1998], and Apergis and Tsoumas [2009]).

Studies on FHP differ in terms of methodology and in terms of different econometric techniques as well, where cross-sectional data (see Feldstein-Horioka [1980], Murphy [1984], Penati and Dooley [1984], Dooley et al. [1987], Coakley et al. [1998], Herwartz and Xu [2010]), time-series (see Miller [1988], Argimon and Roldan [1994], Jansen [1996], Coakley and Kulasi [1997], Caporale et al. [2005]) as well as panel data (see Corbin [2001], Ho [2002], Fouquau et al. [2008], Kollias et al. [2008], Georgopoulos and Hejazi [2009], Vasudeva Murthy [2009], Rao et al. [2010], Herwartz and Xu [2010]) were employed.

Empirical studies using panel data vary in their results according to different applied econometric techniques. For example, Fouquau et al. (2008) in a panel study on 23 OECD countries used the panel smooth transition regression model, where the saving-retention coefficient was broken down into five classes presented by factors that mostly have an effect on countries' capital mobility. These factors are economic growth, demography, degree of openness, country size and current account balance. The results of this study indicate the strong heterogeneity in the capital mobility of developed countries. It was found as well that the estimated coefficients for the OECD sample fall generally between the years 1960 and 2000.

Kollias et al. (2008) employed the bounds testing procedure to test for the presence of cointegration in a cross-sectional sample of 15 European Union members for the 1962-2002 period. At the same time, the authors applied panel data techniques to test for individual and temporal effects in the sample. The results indicated that the country specific parameter is a random variable, while the time specific parameter is a fixed variable with the saving-retention coefficient being at a level between 0.148-0.157, indicating high capital mobility in the sample group.

Banerjee and Zanghiery (2003) used a sample of 14 European Union members over the period 1970-2002. They employed the Johansen country-by-country cointegration test and Pedroni panel cointegration test. The results mostly support the integration hypothesis in the data series. At the same time, the authors emphasize that the consideration of the groups of countries and the cross-unit cointegration possibility is essential in the results' sensitivity.

Most empirical studies with panel data have concentrated on large samples of OECD countries following the work of Feldstein and Horioka (1980) (see, for example, Ho [2002], Fouquau et al. [2008], Adedeji and Thornton [2008]). Another group of studies narrows its focus to European Union countries (for example, Banerjee and Zanghieri [2003], Telatar et al. [2007], Kollias et al. [2008]) or to smaller samples of OECD countries (Georgopoulos and Hejazi [2009], Rao et al. [2010], Narayan and Narayan [2010]). Another study compares groups of developed and developing countries (for example, Sinha and Sinha [2004], Adedeji and Thornton [2008], Herwartz and Xu [2010]). Thus Sinha and Sinha (2004) in their study of 123 countries found evidence for capital mobility for only 16 countries, most of which are developing countries. Taking into account that macroeconomic series such as investment and savings are sensitive to economic and political changes domestically as well as world-wide, it is important to analyze saving-retention coefficients in the presence of structural breaks, if such exist. However, there are few studies on FHP in OECD members that take into account the existence of structural shifts. For example, Ozmen and Parmaksiz (2003), Telatar et al. (2007), Mastroyiannis (2007), Kejriwal (2008) in their studies analyze FHP with the possibility of structural breaks in individual countries or in cross-sectional samples. Only a few studies consider structural changes in the panel data of developed countries (for example, Iorio and Fachin [2007], Telatar et al. [2007], Rao et al. [2010]).

The results of FHP analysis vary with the employed econometric techniques, the inclusion of structural changes, the employed country samples and with different time periods. Therefore, it is difficult to make general conclusions on FHP analysis in the literature due to the absence of homogeneity in studies.

This study employs a sample of OECD countries and makes a comparative analysis of different groups that are generated from OECD countries. Particularly in this study four different groups of countries are considered: OECD, EU15, NAFTA and G7. Members of European Union countries have higher possibility to have homogenous investment saving relations (see, for example, Blanchard and Giavazzi [2002]). At the same time members of more narrowed groups such as NAFTA and G7 are more likely to have homogeneous investment policies as well compared to a wider group of countries such as OECD. The purpose of this study is to examine investment-saving associations and to find out how they change in different groups of developed countries in the presence of structural breaks where such exist and in the absence of structural changes when they are not detected. At the same time, this study compares the results of panel cointegration tests with and without the inclusion of structural breaks when it is necessary. This study investigates the sensitivity of results when developed countries are divided into more homogenous groups and when the existing structural breaks are counted in estimations.

The data sample of this study includes 26 member OECD countries except Chile, Czech Republic, Hungary, Poland and the Slovak Republic for a lack of homogenous data for these countries for the full considered period in the used source. The annual data for the 1970-2008 period are extracted from the official statistical site of the OECD. The rest of the paper is organized as follows. In the next section the applied methodological approach is presented. In section 3 the obtained empirical results are reported and, finally, the last section concludes.

2. Methodology

This study investigates the degree of capital mobility in OECD members compared to different narrowed groups of developed countries taking into account identified structural breaks. In order to examine the level of capital mobility in OECD countries, Feldstein and Horioka (1980) estimated the following equation:

$$\left(\frac{I}{Y}\right)_i = \alpha + \beta\left(\frac{S}{Y}\right)_i + e_i \qquad (1)$$

Where I is gross domestic investment, S is gross domestic savings and Y is gross domestic product of considered country i. Coefficient β, which is known as a saving retention coefficient, measures the degree of capital mobility. If a country possesses perfect international capital mobility, the value of β has to be close to 0. If the value of β is close to 1, it would indicate the capital immobility of the country. The results of Feldstein Horioka (1980) showed that the value of β for 21 open OECD economies changes between 0.871 and 0.909, illustrating by this the international capital immobility in the considered countries. These controversial results gave start to widespread debates in the economic literature. Numerous studies have provided evidence supporting these results. At the same time, different results exist in the literature with a wide array of interpretations. Therefore, the findings of Feldstein Horioka (1980), which are contrary to economic theory, have started to be referred to as “the mother of all puzzles” (Obstfeld and Rogoff, 2000, p.9).

In this paper different tests for the panel unit root are used. The first group consists of tests that do not allow for structural changes in series. These are the Levin, Lin and Chu (LLC) test (Levin et al., 2002), the Breitung (Breitung, 2000) test, the Im, Pesaran and Shin (IPS) test (Im et al. 2003), the Fisher-type tests using ADF and PP tests (Maddala and Wu (1999) and the Choi (2001), and the Hadri (Hadri, 2000) test. The LLC test is based on orthogonalized residuals and on the correction by the ratio of the long-run to the short-run variance of each variable. Although the LLC test has become a widely accepted panel unit root test, it has homogeneity restriction, allowing for heterogeneity only in the constant term of the ADF regression. The Breitung test assumes that all panels have common a autoregressive parameter and the presence of the common unit root process. The IPS test is a heterogeneous panel unit root test based on individual ADF tests and was proposed by Im et al. (2003) as a solution to the homogeneity issue. This test allows for heterogeneity in both the constant and slope terms of the ADF regression. Maddala and Wu (1999) and Choi (2001) proposed an alternative approach by using the Fisher test, which is based on combining the P-values from the individual unit root test statistics such as ADF and PP. One of the advantages of the Fisher test is that it does not require a balanced panel. Finally, the Hadri test is a heterogenous panel unit root test that is an extension of the test of Kwiatkowski et al. (1992), the KPSS (Kwiatkowski–Phillips–Schmidt–Shin) test, to a panel with individual and time effects and deterministic trends, which has as its null the stationarity of the series.

However, the considered unit root tests do not take into account the presence of any structural shifts in series. Therefore, as proposed by Im et al. (2005), the LM unit root test was employed. This is a panel extension of the Schmidt and Phillips (1992) test allowing for one and two structural shifts in the trend of a panel and of every individual time series. Im et al. (2005) illustrated that in the series where structural shifts do not exist the size of distortions and loss of power in the panel unit root tests remain insignificant when structural shifts are accommodated. However, size distortions and loss power in the tests were found to be significant when unit root tests were applied to the time series without taking into account the existing structural shifts. The break date in the Im et al. (2005) test is chosen using the minimum LM statistics of Lee and Strazicich (2003, 2004). In this method, the break date is selected when the t-statistic of possible break points is minimized.

In order to be able to apply panel cointegration tests allowing for structural shifts, it is necessary to examine series for stability. The Hansen's (1992) stability test was employed in this study to estimate parameter stability in cointegration relationships. The test is based on the fully modified OLS residuals proposed by Phillips and Hansen (1990). A necessary requisite of the test is that series have to be non-stationary. The stability test produces three test statistics: *supF*, *meanF* and *Lc*. The *supF* statistic tests for the null hypothesis of cointegration with no structural shift in the parameter vector against the alternative hypothesis of cointegration in the presence of sudden structural shifts. The *meanF* and *Lc* statistics test for a cointegration with constant parameters against an alternative hypothesis of gradual variance in parameters, which is considered no cointegration. Particularly, the *meanF* statistic is used to capture the overall stability of the model.

Cointegration tests were employed in this study in order to determine whether long-run relationships exist between investment and savings. Two of them are the Kao (1999) and the Pedroni (1999) cointegration tests, which do not allow for structural shifts in series. The next one is the Westerlund (2006) panel cointegration test, which allows for multiple structural breaks in series. The following system of cointegrated regressors is considered for estimation in cointegration tests:

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it} \qquad (2)$$

Where i=1,…, N, and t=1,…., T, α_i are constant terms, β is the slope, y_{it} and x_{it} are non-stationary regressors, and ε_{it} are stationary disturbance terms. Kao (1999) proposed two types of panel cointegration tests, the Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) tests. The statistics of these tests can be calculated using the following formula:

$$\widehat{\varepsilon}_{it} = \rho\widehat{\varepsilon}_{it-1} + \sum_{j=1}^{p}\theta_j \Delta\widehat{\varepsilon}_{it-j} + u_{it} \qquad (3)$$

Where the residuals derived in the system (2) are used to calculate the test statistics (3) and to tabulate the distributions. The null hypothesis of the test is $H_0 : \phi = 1,$ versus alternative $H_1 : \phi < 1$.

Pedroni (1999) developed a panel and group cointegration test where seven residual-based tests (with four panel statistics and three group statistics) were introduced in order to test the hypothesis of no cointegration in dynamic panel series with multiple regressors. The first four panel cointegration tests, which are defined as within-dimension- based statistics, use the following null and alternative hypotheses: $H_0 : \phi = 1,\ \ H_1 : \phi < 1$, assuming the homogeneity of coefficients under the null hypothesis. The other three group statistics, which are defined as between-dimension-based statistics, use $H_0 : \phi_i = 1,$ versus $H_1 : \phi_i < 1$ for all i. In this case for each ith unit it is necessary to calculate N coefficients ϕ_i from equation (3), where slope heterogeneity across countries is now allowed under the alternative hypothesis.

In the long run, macroeconomic series such as investment and savings may contain a variety of structural changes within a country or at the international level. Therefore, in order to examine the regression model (1) in the case when structural breaks are detected, Westerlund (2006) methodology is employed in this study. This is the panel cointegration test that allows for multiple structural breaks accommodation in the level as well as in the trend of cointegrated regression. This test is based on the panel cointegration residual-based LM test proposed by McCoskey and Kao (1998), which does not allow for structural shifts. The advantage of Westerlund's test is that it allows for the possibility of known a priori multiple structural breaks or it allows for breaks the locations of which are determined endogenously from the series. At the same time this test allows for a possibility of structural breaks that may be placed at different locations in different individual series. Westerlund (2006) showed in his work that the test is free of nuisance parameters under the null hypothesis and that the number and location points of structural shifts do not affect the limiting distribution. The null of the test is $H_0 : \phi_i = 0$ for all $i = 1,....,N$, versus alternative hypothesis: $H_1 : \phi_i \neq 0$ for $i = 1,....,N_1$, and $\phi_i = 0$ for $i = N_1 + 1,....,N$. One of important advantages of this test is that the alternative hypothesis is not just a general rejection of the null like in the commonly used LM panel cointegration test of McCoskey and Kao (1998), but allows ϕ_i to differ across individual series.

Finally, in order to estimate saving-retention coefficients for groups of countries ordinary least squares (OLS), dynamic OLS (DOLS) and fully modified OLS (FMOLS) techniques were employed. DOLS and FMOLS estimators were proposed by Kao and Chiang (2001) for heterogeneous panels. DOLS and FMOLS estimators have the same asymptotic and limiting distributions and correct standard OLS for serial correlation and endogeneity that may present in long-run series. Kao and Chiang (2001) illustrated that DOLS outperform OLS and FMOLS estimators in estimating cointegrated panel regressions.[2] However, in the present study all of described estimators, OLS, FMOLS and DOLS are employed for comparative purpose.

3. Empirical Results

First, in order to examine the cointegrating relationships between investment and savings panel series and to estimate saving retention coefficients for the considered groups of

[2] For technical details of FMOLS and DOLS estimators, see Kao and Chiang (2001).

developed countries, OECD, EU15, NAFTA and G7, it is necessary to investigate the integration order of panel series. Six alternative unit root tests, the LLC, Breitung, IPS, ADF, PP and Hadri tests, were employed in order to test for the presence of the unit root in panel series. The LLC and the Breitung tests have a null hypothesis of the common unit root process presence; the IPS, the ADF and the PP test for a presence of individual unit root process in series; and finally, the Hadri test's hypothesis is no unit root in the common unit root process. The results of the unit root tests are presented in Table 1. The Investment and Savings series in general for all four groups demonstrated the presence of the unit root in levels and no unit root process in their first differences. However, the LLC test rejected the hypothesis of the unit root presence in the levels of the OECD, EU15 and G7 investment series and in the OECD and EU15 savings series. The IPS test rejected the presence of the individual unit root process in the investment series for the EU15 group. However, Banerjee et al. (2004, 2005) illustrated in their studies that if common sources of non-stationarity exist, tests such as the LLC and IPS tend to over-reject the null hypothesis of non-stationarity in series. The LLC test is based on the pooled regressions, therefore this test may not perform well compared to other tests in the case where there is no need for pooling in series. Im et al. (2003) illustrated that the LLC test tends to over- reject the null hypothesis in the case of models with serially correlated errors. Breitung (2000) demonstrated that if individual specific trends are included in pooled series the LLC and IPS tests may lose power. Therefore, based on the results of the alternative unit root tests, it can be concluded that the Investment and Savings series for all countries' groups are generated by a non-stationary stochastic process.

The prerequisite of Hansen's (1992) stability test is that the variables have to be non-stationary. The results of the various panel root tests presented in Table 1 indicated the existence of unit root in the considered variables. However, in order to acquire stronger evidence of a unit root presence in unstable as well as in stable series, the panel unit root tests proposed by Im et al. (2005) that allow for one and two structural shifts in series were applied. The results for the LM unit root tests with structural shifts for OECD, EU15, NAFTA and G7 groups are reported in Tables 3-8. Both types of unit root tests with one and with two structural shifts provide strong evidence of the unit root presence in the panel series of all four considered groups of countries. The LM statistics for individual countries failed to reject the stationarity hypothesis in many cases where one structural shift was allowed. However, the tests in which two structural shifts were allowed, demonstrated stronger power to reject the null hypothesis of series' stationarity.

Based on the results of the panel unit root tests which are reported in Table 1 and in Tables 3-8, investment and savings series are accepted as non-stationary, therefore Hansen's (1992) stability test can be applied. The results of the stability tests for all considered countries are presented in Table 9. Only in the cases of Australia and Spain *supF* do the statistics reject the null hypothesis of the stability of model parameters indicating the presence of structural change in parameters, while in all other cases the model parameters appeared stable. The *meanF* statistic, in the cases of Australia, Canada, Greece, Italy, the Netherlands, New Zealand, Norway, Portugal, Spain, Switzerland, Turkey and the United States, reject the hypothesis of cointegration in favor of the instability of the overall model in the considered countries. The *Lc* statistic rejects the hypothesis of constant parameters in most cases where the *MeanF* statistics found instability in the overall model. Countries where the stability of parameters is rejected are: Australia, Canada, Greece, the Netherlands, New Zealand, Norway, Portugal, Spain, Switzerland and the United States. The results of the stability test moderately clearly divide the considered countries into two groups. The first group consists of countries where no evidence was found for the presence of structural shifts, and these countries are: Austria, Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Japan, Korea, Luxemburg, Mexico, Sweden and the United Kingdom. In these countries none of the applied tests provides evidence of instability. Another group consists of countries where at least one of the stability tests detected the presence of sudden structural shifts in the model. These countries are: Australia, Canada, Greece, Italy, the Netherlands, New Zealand, Norway, Portugal, Spain, Switzerland, Turkey and the United States.

After investigating the stability properties of cointegrating vectors, the Westerlund (2006) panel cointegration test with multiple structural breaks can be applied to the instable series. Tables 10-13 present the results of the panel cointegration test allowing for multiple structural shifts. The test was applied to the OECD, EU15, NAFTA and G7 groups, where only countries which were found instable by the stability test (Table 9) were included. The test was applied with the option to detect maximum five structural breaks. Panel A demonstrates the results of the test in which structural shifts are allowed in constant, while Panel B illustrates test results where structural shifts are allowed in both constant and trend of the regression. The results indicate that the test detected different break locations for the estimated countries. However, a tendency may be followed in results around some particular dates. For example, there is a prevalence of breaks (in constant and in constant and trend) occurring in the period 1974-1977 for such countries as Canada, Greece, Italy, the Netherlands, New Zealand, Norway, Portugal, Spain, Switzerland, Turkey. This can be explained by some historical facts that occurred at that time and had long-rung negative effects on industrialized economies. The years 1973 and 1974 were characterized by high oil world prices, the growth of which was stimulated by the embargo proclaimed by the Organization of Arab Petroleum Exporting Countries to the United States. As a result, the Organization of Petroleum Exporting Countries started to raise world oil prices. The oil price shock in those years combined with the stock market crash in the same period led to the suppression of the economic activities of many developed countries.

The statistics of the LM panel test in all groups of countries differ for the case when breaks are allowed only in level and for the case when breaks are allowed in level and in trend. In the case when a break is allowed only in constant estimated statistics, for the OECD, EU15, NAFTA and G7 groups, it does not reject the hypothesis of cointegration, while in cases when a break is allowed in constant and trend, the LM statistics reject the null hypothesis, providing no evidence for cointegration in all considered panels. Thus, it can be concluded that the investment and savings variables in the panels with unstable models are cointegrated only around a broken intercept.

The Pedroni (1999) and Kao (1999) panel cointegration tests were employed to series after finding evidence of variables non-stationarity (Table 1). Table 2 presents the results of the Pedroni (1999) and Kao (1999) panel cointegration tests. The panel cointegration tests are applied to four groups: OECD, EU15, NAFTA and G7. Only two statistics out of seven in the Pedroni test provided evidence of cointegration between investment and savings series in the cases of the OECD and EU15 countries. However, in the case of NAFTA and G7 groups, the Pedroni test did not provide any evidence of the presence of cointegrating relationships between variables. The results of the Kao panel cointegration test demonstrate the evidence of cointegration existence between investment and savings series in OECD, EU15 and G7 groups and the Kao test did not provide any evidence in favor of cointegration in the NAFTA group. The Kao cointegration test is quite sensitive to the information criterion used and to lag selection. For example, the test does not reject the hypothesis of no cointegration in the OECD and EU15 groups, choosing maximum 4 and 5 lags based on AIC and HQIC. As a result, it can be seen that there is fairly weak evidence in favor of the presence of cointegrating relationships in the OECD and EU15 groups and no evidence was found for cointegration in the NAFTA and G7 groups. Thus, there is not enough evidence to support the existence of long-run relationships between savings and investments in developed countries.

The results of the Pedroni and the Kao cointegration tests for the panels of the OECD, EU15, NAFTA and G7 series which are presented in Table 2 did not provide significant evidence for cointegrating relationships between the investment and saving variables. At the same time, the test for cointegration with multiple structural breaks detected the presence of cointegration in unstable series around broken intercept. However, in order to have full analysis of capital mobility in developed countries, it is necessary to test for cointegration in panels where only stable countries are included. Therefore, Table 14 presents the results of the Pedroni and the Kao panel cointegration tests, where OECD, EU15, NAFTA and G7 groups are divided into groups with unstable countries (U) and into groups with stable countries (S). In the case of NAFTA, the Pedroni and the Kao panel tests could not be applied to the subgroup of stable countries due to panel absence. In this group only one country, Mexico, is included, therefore the Johansen cointegration test was applied to the Mexico case. From results of Table 14 it can be seen that the division of the NAFTA and G7 groups into stable and unstable countries did not change the results which were extracted from the full sample in Table 2. Thus, in the NAFTA and G7 groups no evidence was found in favor of cointegration among investment and savings variables. In the cases of the OECD and EU15 countries, again weak evidence was found in favor of cointegration among unstable series; however, in the case of stable series, the Pedroni and Kao tests provided stronger evidence of cointegration indicating that investment and savings variables are cointegrated with the panel of stable countries in the OECD and EU15 groups.

Previous studies (for example, Coakley et al., 1996) suggest that cointegration between investment and saving series exist irrespective of level of capital mobility, which is the indication of current account solvency. Thus, the results of cointegration tests indicate on current account insolvency in the NAFTA and G7 groups and on current account solvency in stable countries of the OECD and EU15 countries, with weaker evidence in unstable countries.

Kumar and Rao (2009) in their panel study on 13 OECD countries applying the Pedroni (1999) cointegration test found some evidence of cointegration in series as well; however, dividing the panel into pre- and post- Bretton Woods and pre- and post- Maastricht sub-samples decreased the significance of test statistics providing less evidence in favor of cointegration. Similar to the results of the present study, Narayan and Narayan (2010) in their panel analysis of G7 countries applying the Pedroni (1999) cointegration test, did not find any evidence of cointegration between investment and savings series. The authors concluded that the absence of long-term relationships between variables indicates the highly mobility of capital in G7 countries.

Finally, this study examines the saving retention coefficient β from Equation 1 by employing least squares (OLS, DOLS and FMOLS) estimators. The results, presented in Table 15, do not show significant difference in coefficient estimates when different least squares estimators were employed. Saving retention coefficients are considered for all considered groups of developed countries, dividing them in 3 different cases, total, unstable and stable. The first case indicates coefficient estimates for panels where all countries of the particular group are included. In the second case only unstable countries are included in estimations, while in the last case, only stable countries are included.

In all cases, except for the NAFTA stable group, the saving retention coefficient was found with the expected positive sign. The saving retention coefficient in the OECD group is estimated at 0.222[3], where the division of this group by unstable and stable countries did not change its magnitude significantly. The saving retention coefficient for EU15 countries is estimated even at a lower level than for OECD countries, 0.096 for the full sample, and 0.083 and 0.119 for the unstable and stable groups, respectively. These results contradict the Feldstein-Horioka (1980) results, indicating capital mobility in OECD countries. Similar results are found in Kollias et al. (2008) where the saving retention coefficient for EU15 1962-2002 period was found at the 0.148 level. The saving retention coefficient in the Kumar and Rao (2009) panel study on 13 OECD countries was found to be very sensitive to the choice of period and model. Thus, they found that the saving retention coefficient for the pre-Bretton Woods period in the model with random effects is 0.742, while the estimation of model with fixed effects for the post-Bretton Woods period generated a saving retention coefficient at the level 0.266.

The coefficient estimates for NAFTA are 0.346 and 0.398 for total and unstable panels, respectively, while in the case of stable countries the saving retention coefficient appeared to be negative -0.552 in all three cases of coefficient estimates, OLS, DOLS and FMOLS. The stable case of NAFTA includes only one country, Mexico. The negative association between investment and savings was detected and explained in previous studies on capital mobility (see, for example, Özmen [2007], Fouquau et al. [2008]). For example, Westphal (1983) in his study provided theoretical explanation for the existence of negative relations between investments and savings. Particularly, a high world interest rate leads domestic interest rates to increase promoting by this growth in domestic savings and decline in domestic investments. In the G7 group, however, saving retention coefficient estimates

[3] Even though estimates of OLS, DOLS, and FMOLS do not differ significantly, in the saving-retention coefficient discussion, DOLS estimates are used.

differ from other estimates according to group division. Thus, the saving retention coefficient is estimated at the level 0.754 in the full sample and at levels 0.482 and 0.864 in the unstable and stable panels of G7 group. The results illustrate that the group of unstable countries in the G7 group, which are Canada, Italy and the United States, have a saving retention coefficient which indicates moderate capital mobility in these countries. The stable countries of the G7, which are France, Germany, Japan and the United Kingdom, appeared to have low capital mobility. Thus, only the extraction of the most developed countries from the OECD group with stable economies appeared to fall in the Feldstein-Horioka puzzle.

The results illustrate that saving retention coefficient estimations are significant in panel samples. The wider panel of developed countries is considered the more general results are obtained. Therefore, the division of considered panels in groups with more common characteristics provides different and more specific results.

4. Conclusion

This paper examined the validity of the Feldstein-Horioka puzzle for the panel sample of OECD countries. The OECD countries were analyzed in more narrow groups as well, EU15, NAFTA and G7, in order to compare the results of the analysis of developed countries when they are combined in different panels. Recently developed econometric methods were applied to annual series in order to investigate the cointegrating relationships of investment and savings variables, taking into account the presence of structural shifts in the model when it was relevant and to estimate the saving retention coefficient. To detect series where structural shifts took place, the Hansen's (1992) stability test was employed. As a result, 12 countries out of 26 OECD countries were exposed as unstable countries. The Westerlund (2006) cointegration test was applied to four groups of countries, OECD, EU15, NAFTA and G7, where only unstable countries were included, allowing for maximum five breaks. As a result, evidence of cointegration was found only in the presence of constant, while no evidence was found when constant and trend are included. The Pedroni and Kao panel cointegration tests did not provide any evidence of cointegration for the NAFTA and G7 panels when tests were run for full samples and for sample divided into stable and unstable groups. In the case of the OECD and EU15 countries, the Pedroni and Kao tests provided fairly weak evidence of cointegration between investment and savings variables. However, when these panels were divided into stable and unstable groups, tests for groups with stable countries with constant inclusion provided much stronger evidence for cointegration presence than for full samples and for samples with unstable countries indicating long-run relationships between investment and savings in stable OECD and EU15 countries.

Finally, a saving retention coefficient was estimated for the OECD, EU15, NAFTA and G7 groups and for their unstable and stable subgroups. DOLS estimations indicated the lowest coefficient 0.096 for the EU15 group and the highest 0.784 for the G7 group. The division of the full sample by stable and unstable groups did not change the results significantly except for the G7 group, where the saving retention coefficient for the unstable group was estimated at the 0.482 level, and for the group with the stable countries, the saving retention coefficient increased to 0.864.

This study illustrates that the analysis of capital mobility in OECD developed countries is sensitive to panel selection, OECD, EU15, NAFTA or G7. The presence of uncounted structural shifts may lead to the underestimation of cointegration tests and saving retention coefficients. The results of this study illustrate that the Feldstein-Horioka puzzle exists only in the panel of G7 countries, while the extraction of unstable countries significantly decreases the saving retention coefficient.

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Table 1 Unit root tests

	OECD		EU15		NAFTA		G7	
	level	Δ	level	Δ	level	Δ	level	Δ
Investment								
LLC[a]	-2.39*	-12.72*	-2.75*	-8.89*	-0.54	-6.16*	-1.65*	-6.88*
	I(0)	I(0)	I(0)	I(0)	I(1)	I(0)	I(0)	I(0)
Breitung[a]	-1.47	-7.30*	-1.33	-4.68*	-0.47	-4.48*	-0.78	-5.11*
	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)
IPS[b]	-1.52	-11.62*	-2.04*	-8.79*	-0.53	-4.51*	-1.43	-5.61*
	I(1)	I(0)	I(0)	I(0)	I(1)	I(0)	I(1)	I(0)
ADF[b]	68.53	227.16*	43.87	130.46*	7.38	30.03*	21.91	55.75*
	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)
PP[b]	27.54	379.42*	17.03	249.14*	2.03	27.72*	4.89	50.79*
	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)
Hadri[c]	11.58*	2.73*	8.77*	1.10	3.58*	1.84*	5.45*	0.51
	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(0)
Savings								
LLC	-2.06*	-14.21*	-1.89*	-10.82*	0.31	-3.26*	-0.48	-6.70*
	I(0)	I(0)	I(0)	I(0)	I(1)	I(0)	I(1)	I(0)
Breitung	0.52	-11.19*	0.05	-8.62*	-0.22	-2.57*	-0.66	-5.05*
	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)
IPS	-0.97	-14.94*	-0.35	-11.33*	-0.88	-4.01*	-1.43	-8.33*
	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)
ADF	61.83	296.58*	31.32	170.61*	8.06	26.59*	20.47	86.36*
	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)
PP	48.47	589.12*	28.02	358.87*	5.01	35.71*	16.61	106.88*
	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)
Hadri	9.97*	5.07*	8.66*	4.42*	0.47	1.04	3.13*	1.73*
	I(1)	I(1)	I(1)	I(1)	I(0)	I(0)	I(1)	I(1)

Note: Estimations are made with inclusion of constant and trend, estimations are made with 1 specified lag, with increase of lag length the power of tests increases in favor of unit root presence in level estimations.
* denotes significance at the 5% significance level
a. tests the hypothesis of the presence of the common unit root process
b. tests the hypothesis of the presence of the individual unit root process
c. tests the hypothesis of no unit root in the common unit root process.

Table 2 Panel cointegration tests

	OECD		EU15		NAFTA		G7	
	c	c&t	c	c&t	c	C&t	c	c&t
Pedroni								
Panel v-Statistic	1.70*	-1.37	1.02	-0.69	0.42	-0.84	0.56	-0.22
Panel rho-Statistic	-1.28	0.14	-1.24	-0.12	-0.50	0.11	0.14	1.18
Panel PP-Statistic	-1.06	-0.43	-1.58	-0.91	-0.13	0.07	0.22	1.15
Panel ADF-Statistic	-2.32**	-2.65**	-2.69**	-2.91**	-0.14	0.11	-0.80	0.46
Group rho-Statistic	1.07	2.19	0.59	1.42	0.82	1.28	1.43	2.05
Group PP-Statistic	0.26	1.16	-0.89	0.27	1.13	1.18	1.05	1.92
Group ADF-Statistic	-1.52	-1.67*	-2.81**	-2.74**	0.92	0.38	-0.45	0.99
Kao								
ADF	-4.09**		-4.09**		-1.23		-1.96*	

Note: The critical values are based on Pedroni (2004). Hypothesis for Pedroni cointegration test: No cointegration. ** and * reject hypothesis of no cointegration at 1% and 5% level of significance.
Lag selection is based on the SIC with maximum 3 lags.

Table 3. Panel unit root test with one structural break - **OECD**

Country	**Investment**			**Saving**		
	LM	*Break*	*Lag*	*LM*	*Break*	*Lag*
Australia	-2.799	1999	3	-4.671**	1993	1
Austria	-3.321	1997	0	-4.482*	1994	2
Belgium	-3.390	1989	0	-4.173	1983	0
Canada	-2.688	1990	0	-3.059	1998	2
Denmark	-4.027	1978	3	-4.048	1984	2
Finland	-3.788	1990	1	-3.238	1988	1
France	-4.977*	1994	2	-4.730**	1985	3
Germany	-5.022**	1993	1	-3.028	1992	3
Greece	-4.141	1997	1	-3.135	1990	0
Iceland	-3.770	1994	1	-3.803	1985	0
Ireland	-3.422	1976	3	-3.600	1992	2
Italy	-3.359	2001	1	-4.573**	1983	2
Japan	-2.629	1987	1	-3.514	1992	3
Korea	-4.666**	1993	1	-3.981	1983	1
Luxemburg	-4.897**	1985	0	-3.503	1985	1
Mexico	-4.584**	1984	1	-3.159	1986	3
Netherlands	-4.049	1987	2	-3.415	1986	3
New Zealand	-6.061***	1990	2	-6.100***	1980	3
Norway	-4.675**	1988	2	-2.961	1993	0
Portugal	-3.841	1996	1	-6.597***	1980	3
Spain	-4.018	1980	1	-4.036	1976	3
Sweden	-3.487	1990	1	-3.771	1996	1
Switzerland	-3.799	1983	3	-3.041	1990	1
Turkey	-4.251*	1986	2	-3.755	1980	2
UK	-5.852***	1983	1	-4.707**	1981	2
US	-3.961	1996	1	-3.003	1976	3
MinLM	-3.961	1996	1	-3.003	1976	3
LM statistic	-17.469***			-16.512***		

Notes: For the one break case, the 1%, 5% and 10% critical values for the panel LM test with a break are −2.326, −1.645 and −1.282, respectively. The 1%, 5% and 10% critical values for the minimum LM test with one break are −5.11, −4.50 and −4.21, respectively (Lee and Strazicich (2003)). The 1%, 5% and 10% critical values for the minimum LM test with two breaks are −5.823, −5.286 and −4.989, respectively (Lee and Strazicich [2001,2003]). *denotes significance at the 1% level

Table 4. Panel unit root test with two structural breaks - **OECD**

	Investment				Saving			
	LM	*Break1*	*Break 2*	*Lag*	*LM*	*Break1*	*Break 2*	*Lag*
Australia	-4.169	1979	1998	1	-5.468**	1980	1993	2
Austria	-5.875***	1982	1993	0	-5.863***	1981	1998	2
Belgium	-4.547	1987	2000	3	-5.557**	1977	2002	0
Canada	-4.620	1980	1997	1	-4.593	1980	1997	3
Denmark	-5.352**	1983	1991	3	-4.985*	1981	1997	3
Finland	-5.290**	1979	1991	3	-4.434	1982	1993	1
France	-7.105***	1984	1994	2	-6.761***	1978	1993	3
Germany	-6.076***	1981	1999	3	-4.391	1975	1993	1
Greece	-6.441***	1983	1998	3	-4.739	1975	1992	1
Iceland	-6.129***	1976	1996	2	-4.921	1980	1996	1
Ireland	-7.032***	1979	1993	3	-7.229***	1980	2000	3
Italy	-4.577	1983	1999	3	-5.193*	1975	1992	1
Japan	-7.521***	1987	1996	3	-5.943***	1988	1999	3
Korea	-5.721**	1975	1997	1	-5.871***	1975	1991	2
Luxemburg	-6.079***	1984	1990	2	-4.777	1975	1985	1
Mexico	-6.394***	1987	1984	2	-4.411	1982	1995	0
Netherlands	-5.673**	1975	2001	2	-4.277	1986	1999	3
New Zealand	-7.846***	1980	1990	2	-7.044***	1975	1980	3
Norway	-5.827***	1978	1988	2	-6.136***	1977	1996	1
Portugal	-5.545**	1989	2001	1	-7.974***	1980	1984	3
Spain	-4.610	1984	1995	1	-4.614	1990	1999	3
Sweden	-6.068***	1982	1991	1	-5.514***	1981	1992	1
Switzerland	-5.542**	1981	1990	3	-4.615	1978	2001	1
Turkey	-6.481***	1980	1997	3	-8.360***	1978	1986	3
UK	-7.394***	1983	1997	1	-5.799**	1976	1986	3
US	-5.455**	1986	1996	1	-4.564	1980	1992	3
MinLM	-5.455**	1986	1996		-4.564	1980	1992	
LM statistic	-36.792***				-29.804***			

* denotes significance at the 1% level

Table 5. Panel unit root test with one structural break – **EU15**

Country	**Investment**			**Saving**		
	LM	*Break*	*Lag*	*LM*	*Break*	*Lag*
Austria	-3.763	1998	0	-3.637	1994	1
Belgium	-3.158	1979	1	-4.409*	1988	0
Denmark	-5.003**	1988	3	-3.690	1995	3
Finland	-4.555*	1990	1	-3.336	1988	1
France	-5.748***	1995	2	-4.324*	1985	3
Germany	-4.796**	1993	1	-2.587	1989	3
Greece	-4.186	1988	1	-3.300	1990	0
Ireland	-3.587	1976	3	-3.738	1995	0
Italy	-3.396	1992	1	-5.104**	1983	2
Luxemburg	-5.301***	1990	2	-3.408	1985	1
Netherlands	-3.522	1985	1	-2.818	1986	3
Portugal	-3.851	1996	1	-6.013**	1980	3
Spain	-4.742**	1979	1	-4.195	1980	3
Sweden	-3.471	1990	1	-3.741	1990	1
UK	-6.283***	1983	1	-5.523***	1981	2
MinLM	-6.283***	1983	1	-5.523***	1981	2
LM statistic	-15.108***			-12.892***		

* denotes significance at the 1% level

Table 6. Panel unit root test with two structural breaks – **EU15**

	Investment				Saving			
	LM	*Break1*	*Break 2*	*Lag*	*LM*	*Break1*	*Break 2*	*Lag*
Austria	-5.397**	1982	1996	0	-5.424**	1981	2001	2
Belgium	-3.712	1979	1989	1	-6.648***	1988	2001	2
Denmark	-5.946***	1978	1987	3	-5.301**	1986	1997	3
Finland	-5.464**	1980	1991	1	-4.913	1982	1993	1
France	-6.660***	1978	1995	2	-5.284*	1982	1993	3
Germany	-5.700**	1993	2001	1	-4.431	1986	1998	3
Greece	-6.072***	1983	2000	3	-4.897	1975	1992	1
Ireland	-6.892***	1979	1993	3	-7.321***	1979	2000	3
Italy	-4.988*	1983	2000	1	-5.501**	1983	1997	3
Luxemburg	-6.870***	1984	1990	3	-4.659	1975	1985	1
Netherlands	-5.243*	1975	1999	2	-3.542	1986	1995	3
Portugal	-5.450**	1989	2001	1	-8.549***	1978	1987	3
Spain	-5.241*	1984	1995	1	-5.395**	1988	2002	3
Sweden	-4.806	1986	1999	1	-5.354**	1981	1992	1
UK	-7.419***	1983	2003	1	-6.066***	1981	1986	2
MinLM	-7.419***	1983	2003	1	-6.066***	1981	1986	2
LM statistic	-23.757***				-22.755***			

* denotes significance at the 1% level

Table 7. Panel unit root test with one structural break – **NAFTA and G7**

Country	**Investment**			**Saving**		
	LM	*Break*	*Lag*	*LM*	*Break*	*Lag*
NAFTA						
Canada	-3.786	1995	2	-3.053	1976	1
Mexico	-4.408*	1984	1	-5.200***	1986	3
US	-4.762**	1997	1	-3.893	1980	3
MinLM	-4.762**	1997	1	-3.893	1980	3
LM statistic	-6.668***			-5.921***		
G7						
Canada	-2.972	1991	1	-3.876	1997	3
France	-3.394	1996	2	-5.211***	1986	3
Germany	-4.067	1993	3	-2.862	1975	1
Italy	-4.647**	1999	1	-4.789**	1983	2
Japan	-3.789	1988	3	-2.926	1992	1
UK	-4.482	1982	1	-5.281***	1983	2
US	-3.968	1993	1	-3.082	1975	3
MinLM	-3.968	1993	1	-3.082	1975	3
LM statistic	-8.382***			-8.900***		

* denotes significance at the 1% level

Table 8. Panel unit root test with two structural breaks – **NAFTA and G7**

	Investment				Saving			
	LM	*Break1*	*Break2*	*Lag*	*LM*	*Break1*	*Break2*	*Lag*
NAFTA								
Canada	-5.924***	1985	2000	2	-4.285	1980	1998	1
Mexico	-5.539**	1982	1993	2	-5.545**	1988	2002	3
US	-5.423**	1985	1994	1	-4.050	1980	1993	3
MinLM	-5.423**	1985	1994	1	-4.050	1980	1993	3
LM statistic	-10.461***				-7.542***			
G7								
Canada	-5.822***	1980	1999	3	-5.069*	1982	1997	3
Germany	-5.153*	1980	2002	2	-6.691***	1980	1993	3
France	-5.273*	1992	1999	3	-4.744	1980	1994	1
Italy	-4.817	1992	2000	3	-6.713***	1979	1992	2
Japan	-5.459**	1986	1996	3	-4.905	1987	1999	1
UK	-5.867***	1983	1997	1	-6.063***	1981	1986	2
US	-5.828***	1987	1996	1	-5.007*	1982	1999	0
MinLM	-5.828***	1987	1996	1	-5.007*	1982	1999	0
LM statistic	-15.130***				-15.779***			

* denotes significance at the 1% level

Table 9. Stability tests in cointegrated relations

Country	*SupF*		*MeanF*		*Lc*		*b1*
	test	p-value	Test	p-value	test	p-value	
Australia	2.145	0.01	102.41	0.01	901.61	0.01	-1.70 (0.37)
Austria	0.27	0.20	2.26	0.20	3.53	0.20	0.07(0.32)
Belgium	0.058	0.20	0.65	0.20	3.52	0.20	0.62 (0.37)
Canada	0.34	0.20	5.79	0.07	15.83	0.04	-0.48 (0.18)
Denmark	0.16	0.20	1.29	0.20	3.45	0.20	0.66 (0.39)
Finland	0.11	0.20	2.41	0.20	7.10	0.20	0.29 (0.19)
France	0.02	0.20	1.53	0.20	9.51	0.20	1.71 (1.23)
Germany	0.23	0.20	3.76	0.20	11.09	0.20	0.78 (0.21)
Greece	0.15	0.20	8.14	0.01	27.07	0.01	0.78 (0.10)
Iceland	0.33	0.20	2.23	0.20	5.20	0.20	0.79 (0.86)
Ireland	0.09	0.20	1.11	0.20	2.89	0.20	-0.17 (0.56)
Italy	0.45	0.13	5.42	0.09	8.54	0.20	-0.12 (0.58)
Japan	0.09	0.20	1.39	0.20	3.29	0.20	1.57 (0.52)
Korea	0.05	0.20	0.81	0.20	1.91	0.20	2.15 (1.47)
Luxemburg	0.17	0.20	1.99	0.20	4.43	0.20	0.39 (0.09)
Mexico	0.09	0.20	1.63	0.20	3.62	0.20	-0.89 (0.71)
Netherlands	0.35	0.20	9.05	0.01	67.52	0.01	0.96 (0.15)
New Zealand	0.28	0.20	6.45	0.04	34.04	0.01	-0.07 (0.43)
Norway	0.07	0.20	3.97	0.20	19.97	0.01	-1.02 (0.45)
Portugal	0.46	0.13	14.46	0.01	45.48	0.01	-0.48 (0.44)
Spain	0.89	0.01	12.19	0.01	55.82	0.01	0.18 (0.67)
Sweden	0.09	0.20	4.02	0.20	12.26	0.15	0.24 (0.14)
Switzerland	0.40	0.17	5.47	0.08	24.43	0.01	0.62 (0.23)
Turkey	0.49	0.12	5.97	0.06	12.84	0.12	0.57 (0.15)
UK	0.36	0.20	3.27	0.20	5.64	0.20	-0.31 (0.38)
US	0.81	0.20	30.60	0.01	297.47	0.01	-0.12 (0.38)

Table10. Estimated structural breaks using the approach of Westerlund (2006). **OECD**

Panel A breaks in constant						
Country	Breaks	Date				
Australia	3	1979	1996	2003		
Canada	4	1986	1991	1996	2003	
Greece	1	1997				
Italy	5	1974	1981	1987	1992	1999
Netherlands	1	1974				
New Zealand	3	1975	1994	2002		
Norway	2	1989	1994			
Portugal	5	1974	1983	1988	1996	2002
Spain	4	1977	1987	1998	2003	
Switzerland	1	1985				
Turkey	1	2003				
US	1	1997				
Lm	2.711					
Panel B breaks in constant and trend						
Country	Breaks	Date				
Australia	4	1979	1987	1993	1999	
Canada	5	1974	1983	1989	1996	2001
Greece	3	1976	1983	2001		
Italy	5	1975	1981	1987	1992	2001
Netherlands	5	1976	1984	1883	1998	2003
New Zealand	5	1974	1980	1990	1995	2002
Norway	4	1977	1989	1996	2002	
Portugal	2	1983	1997			
Spain	4	1976	1983	1990	1995	
Switzerland	3	1975	1991	2000		
Turkey	3	1977	1989	2000		
US	4	1980	1985	1992	2003	
Lm	13.919					
No breaks						
Lm	1.521					
Lm (C)	9.606					
Lm (C + T)	7.742					

Table 11. Estimated structural breaks using the approach of Westerlund (2006). **EU15**

Panel A breaks in constant						
Country	Breaks	Date				
Greece		1997				
Italy		1974	1981	1987	1992	1999
Netherlands		1974				
Portugal		1974	1983	1988	1996	2002
Spain		1977	1987	1998	2003	
Lm	1.989					
Panel B breaks in constant and trend						
Country	Breaks	Date				
Greece		1976	1983	2001		
Italy		1975	1981	1987	1992	2001
Netherlands		1976	1984	1993	1998	2003
Portugal		1983	1997			
Spain		1976	1983	1990	1995	
Lm	7.338					
No breaks						
Lm	1.207					
Lm (C)	4.864					
Lm (C + T)	4.345					

Table12. Estimated structural breaks using the approach of Westerlund (2006). **NAFTA**

Panel A breaks in constant						
Country	Breaks	Date				
Canada		1986	1991	1996	2003	
US		1997				
Lm	1.142					
Panel B breaks in constant and trend						
Country	Breaks	Date				
Canada		1974	1983	1989	1996	2001
US		1980	1985	1992	2003	
Lm	7.571					
No breaks						
Lm	0.935					
Lm (C)	3.853					
Lm (C + T)	4.626					

Table13. Estimated structural breaks using the approach of Westerlund (2006). **G7**

Panel A breaks in constant						
Country	Breaks	Date				
Canada		1986	1991	1996	2003	
Italy		1974	1981	1987	1992	1999
US		1997				
Lm	1.466					
Panel B breaks in constant and trend						
Country	Breaks	Date				
Canada		1974	1983	1989	1996	2001
Italy		1975	1981	1987	1992	2001
US		1980	1985	1992	2003	
Lm	8.140					
No breaks						
Lm	0.586					
Lm (C)	4.858					
Lm (C + T)	6.186					

Table 14 Panel cointegration tests

	OECD				**EU15**				***NAFTA***				***G7***			
	c	c&t	c	c&t	c	c&t	c	c&t	c	c&t	c	c&t	c	c&t	c	c&t
Pedroni	***U***		***S***		***U***		***S***		***U***		***S***		***U***		***S***	
Panel v-Statistic	0.89	-0.11	1.45*	-1.49	-0.12	-1.23	1.58*	0.30	0.13	-0.27	-	-	-0.09	-0.85	0.93	0.69
Panel rho-Statistic	-0.12	0.13	-1.55*	0.08	-0.58	0.35	-1.15	-0.55	0.54	0.91	-	-	0.49	1.13	-0.34	0.46
Panel PP-Statistic	-0.02	-0.61	-1.30*	-0.14	-0.92	-0.48**	-1.29*	-0.86	0.94	0.92	-	-	0.65	1.02	-0.34	0.55
Panel ADF-Statistic	-0.28	-2.08**	-2.68**	-1.79*	-1.73*	-2.30	-2.07**	-1.84*	0.61	-0.03	-	-	-0.11	-0.25	-1.00	0.73
Group rho-Statistic	1.16	1.66	0.38	1.45	0.57	1.03	0.32	1.01	1.19	1.39	-	-	1.33	1.73	0.74	1.21
Group PP-Statistic	0.58	0.68	-0.19	0.95	-0.96	-0.22	-0.42	0.48	1.58	1.38	-	-	1.14	1.61	0.39	1.15
Group ADF-Statistic	-0.34	-1.40*	-1.77*	-0.97	-2.26**	-2.64**	-1.85*	-1.49*	1.17	0.19	-	-	0.35	0.09	-0.90	1.23
Johansen											12.94	15.99				
Kao																
ADF	-1.82*		-3.77**		-2.54**		-3.91**		-0.64		-		-1.46*		-1.11	

Note: The critical values are based on Pedroni (2004). Hypothesis for Pedroni cointegration test: No cointegration. ** and * reject hypothesis of no cointegration at 1% and 5% level of significance. Lag selection is based on the SIC with maximum 3 lags.

Table 15 OLS, DOLS and FMOLS estimations

Regions	**Constant**	**β**
OLS		
Total		
OECD	0.163 (0.004)*	0.211 (0.017)*
EU15	0.189 (0.004)*	0.081 (0.019)*
NAFTA	0.119 (0.009)*	0.344 (0.051)*
G7	0.053 (0.006)*	0.728 (0.027)*
Unstable		
OECD	0.167 (0.005)*	0.186 (0.024)*
EU15	0.193 (0.08)*	0.119 (0.039)*
NAFTA	0.109 (0.009)*	0.391 (0.051)*
G7	0.099 (0.009)*	0.479 (0.046)*
Stable		
OECD	0.159 (0.006)*	0.227 (0.025)*
EU15	0.179 (0.005)*	0.103 (0.022)*
NAFTA[1]	0.289 (0.051)*	-0.428 (0.233)
G7	0.032 (0.008)*	0.827 (0.034)*
DOLS		
Total		
OECD	0.159 (0.005)**	0.222 (0.019)**
EU15	0.184 (0.005)**	0.096 (0.022)**
NAFTA	0.118 (0.011)**	0.346 (0.054)**
G7	0.047 (0.005)**	0.754 (0.026)**
Unstable		
OECD	0.170 (0.006)**	0.159 (0.025)**
EU15	0.196 (0.009)**	0.083 (0.042)*
NAFTA	0.109 (0.009)**	0.398 (0.051)**
G7	0.098 (0.008)**	0.482 (0.044)**
Stable		
OECD	0.150 (0.007)**	0.267 (0.030)**
EU15	0.174 (0.006)**	0.119 (0.026)**
NAFTA[1]	0.316 (0.094)**	-0.552 (0.427)
G7	0.023 (0.007)**	0.864 (0.032)**
FMOLS		
Total		
OECD	-0.047 (0.004)**	0.208 (0.018)**
EU15	-0.019 (0.004)**	0.085 (0.019)**
NAFTA	-0.065 (0.009)**	0.346 (0.051)**
G7	-0.146 (0.006)**	0.727 (0.027)**
Unstable		
OECD	-0.039 (0.006)**	0.180 (0.025)**
EU15	0.193 (0.008)**	0.119 (0.039)**
NAFTA	-0.069 (0.009)**	0.398 (0.049)**
G7	-0.089 (0.008)**	0.479 (0.044)**
Stable		
OECD	-0.053 (0.006)**	0.229 (0.026)**
EU15	-0.025 (0.005)**	0.108 (0.022)**
NAFTA[1]	0.087 (0.053)	-0.399 (0.241)
G7	-0.175 (0.007)**	0.824 (0.034)**

[1] in the NAFTA group of stable countries only Mexico is estimated.